A Comparison of Methods for the Detection of Smooth Surface Caries

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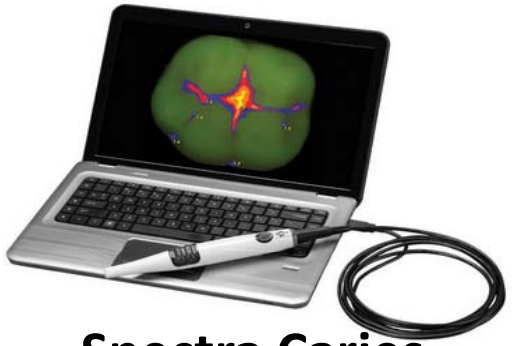
Introduction

- Detection of non-cavitated caries is important because lesion progression may be halted at this stage, remineralized or minimally restored, thereby preserving natural tooth structure.
- Visual and tactile methods of caries detection only examine the tooth surface and not the lesion developing beneath it.
- Smooth surface changes may be detected visually but are there other methods to detect & monitor lesion changes over time?

Objective

This *in vitro* study evaluated the ability of The Canary System, DIAGNOdent, Spectra Caries Detection Aid, ICDAS II, and Radiographic Examination to detect smooth surface caries.



Spectra Caries Detection Aid

The Canary System™

DIAGNOdent

Radiographic Examination

Caries Codes	
0 =	Sound tooth surface
1 =	First visual change in enamel
2 =	Distinct visual change in enamel
3 =	Enamel breakdown, no dentine visible
4 =	Underlying dentinal shadow (not cavitated into dentine)
5 =	Distinct cavity with visible dentine
6 =	Extensive distinct cavity with visible dentine

Visual Examination (ICDAS II)

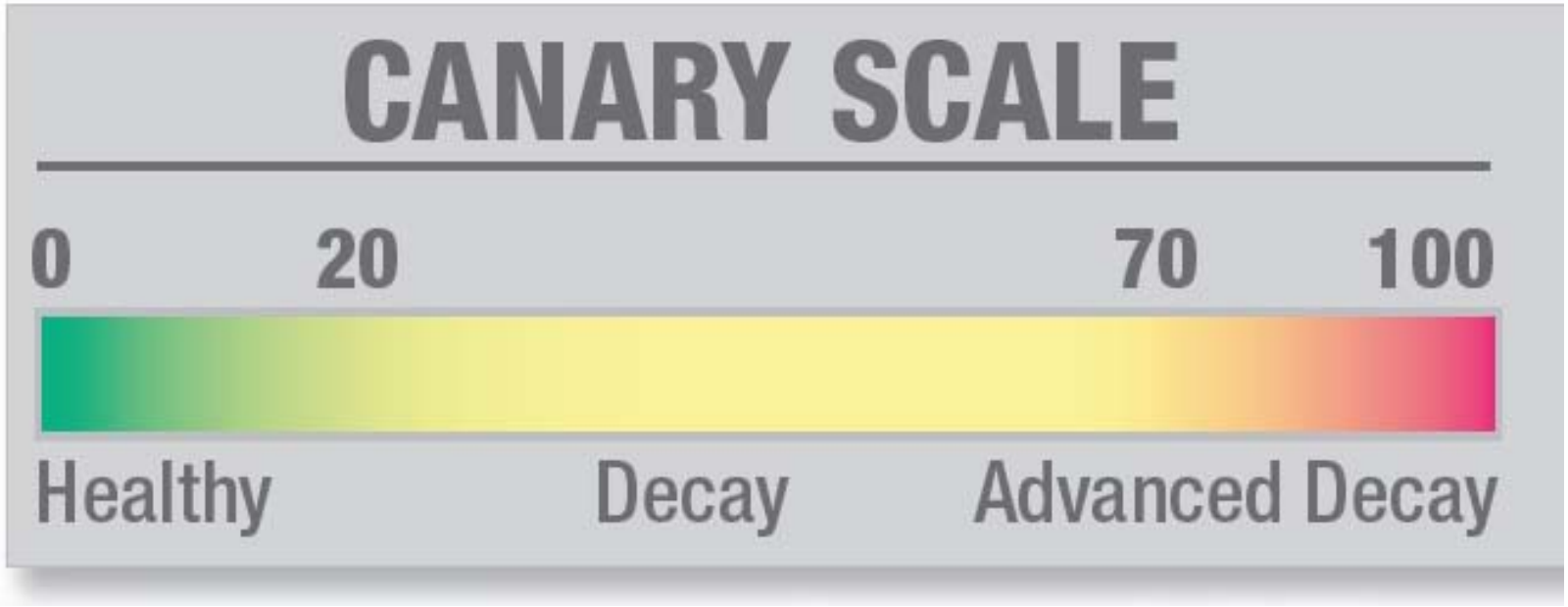
The Canary System

Materials and Methods

- 92 healthy & carious sites on smooth surfaces of extracted human teeth were used.
- A blinded, experienced operator scanned the teeth using The Canary System, DIAGNOdent and Spectra with three repeat measurements per site.
- Two blinded clinicians independently scored the teeth using ICDAS II.
- The same two blinded clinicians independently ranked radiographs of the teeth as '1' for presence of caries and '2' for absence of caries. **Note radiographs were taken with smooth surfaces mounted as interproximal lesions**
- Where there was disagreement between the clinicians' scores, the site were re-examined by both clinicians together and a consensus score reached.

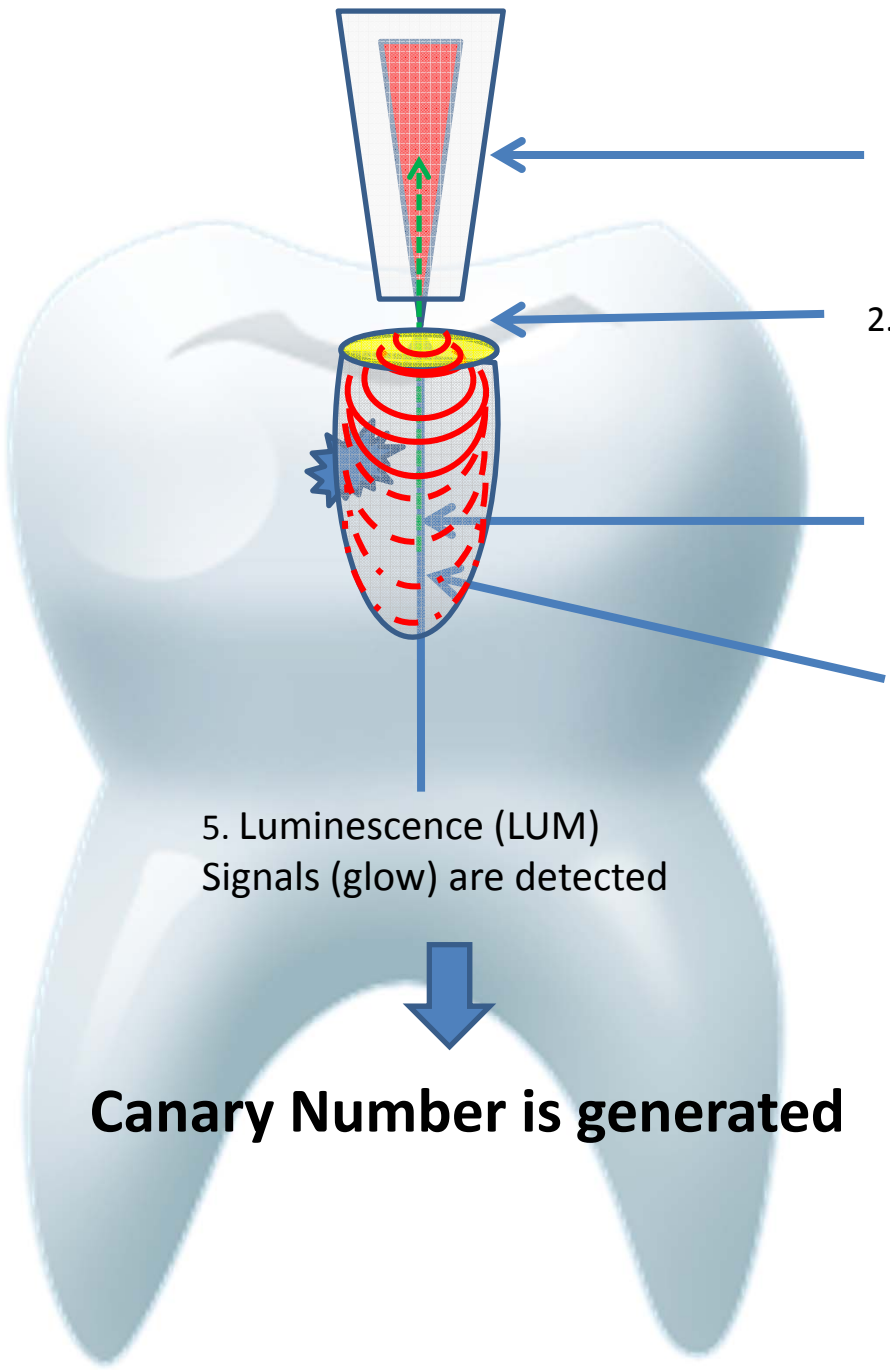
The Canary System

Canary Scale



Source: The Canary System User Manual

The Canary System



1. Plastic Tip touches enamel surface

2. Laser diameter at the contact point =50microns

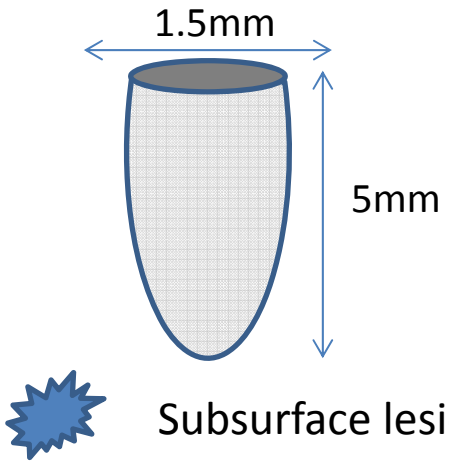
3. Thermal waves (PTR signals) radiate 1.5mm across and up to 5mm deep

4. PTR Amp and PTR-Phase signals are measured by infrared detector

5. Luminescence (LUM) Signals (glow) are detected

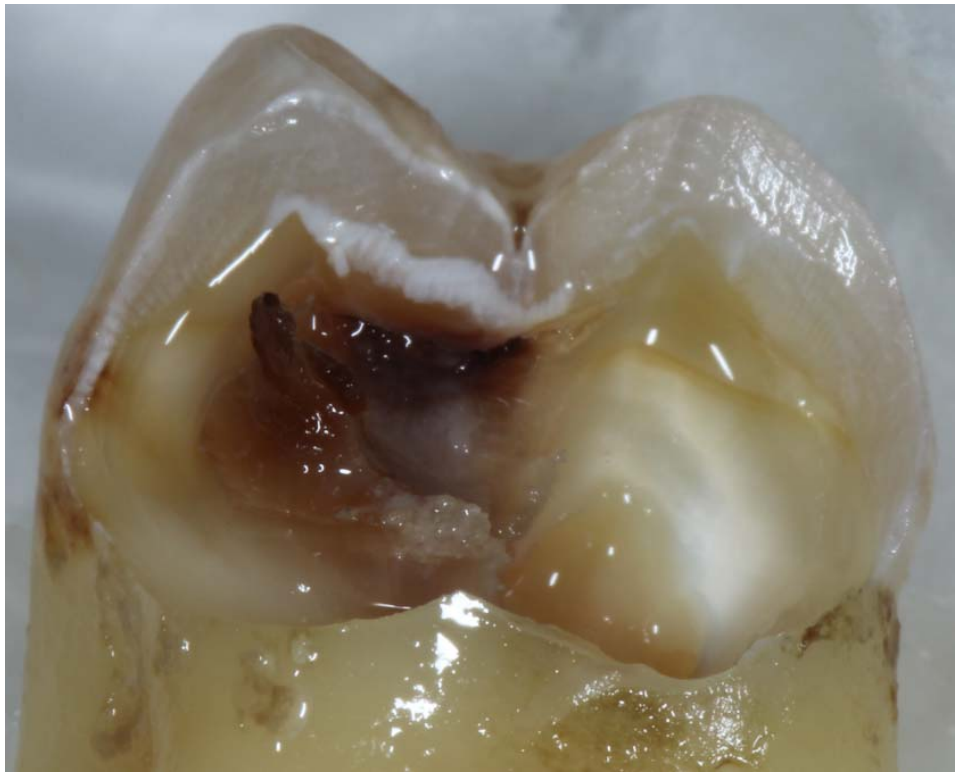
Canary Number is generated

SCAN VOLUME



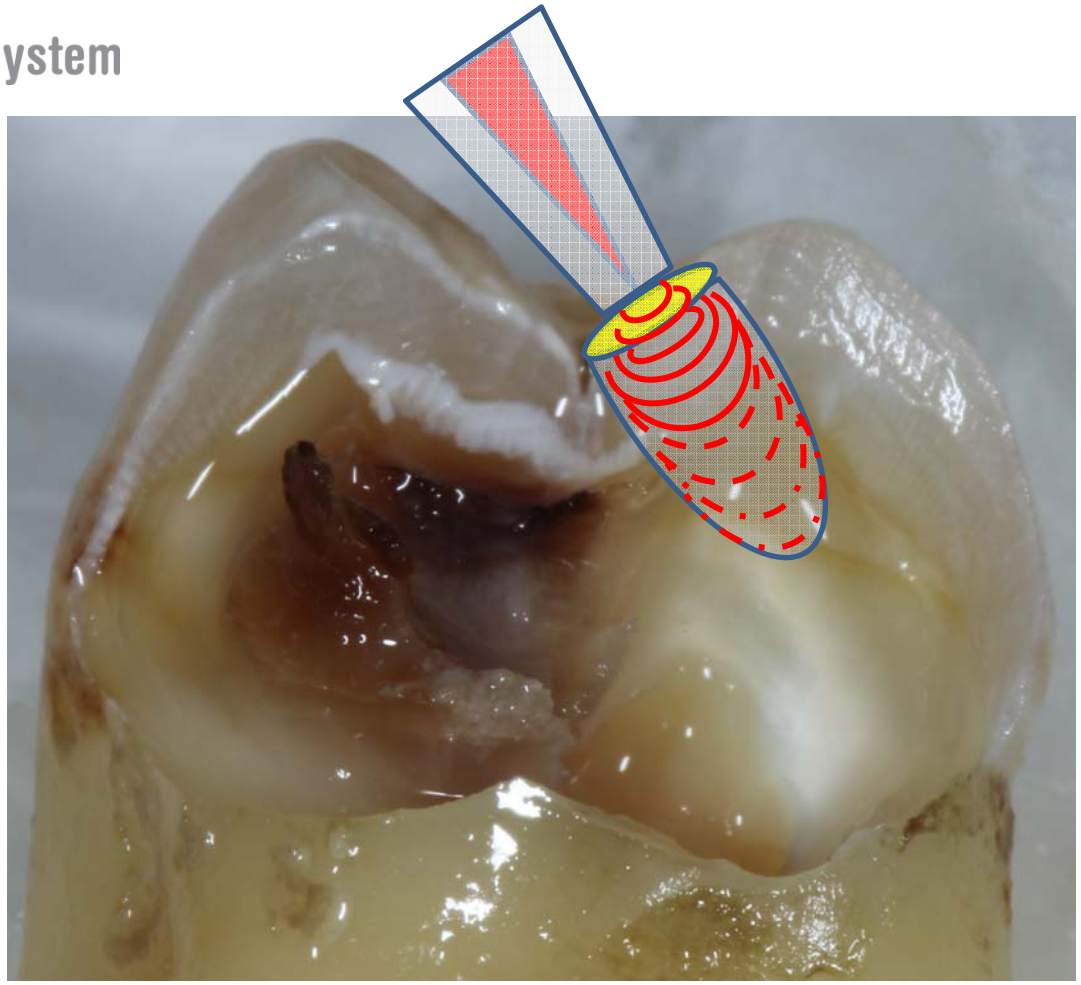
Subsurface lesion

Examining Lesions with Canary



- Angulation of Canary Tip will provide a range of Canary Numbers depending upon what is beneath the beam
- As one scans along the occlusal surface one can detect & image the lesion.
- The Canary acts like a “punch biopsy” for examining the tooth surface

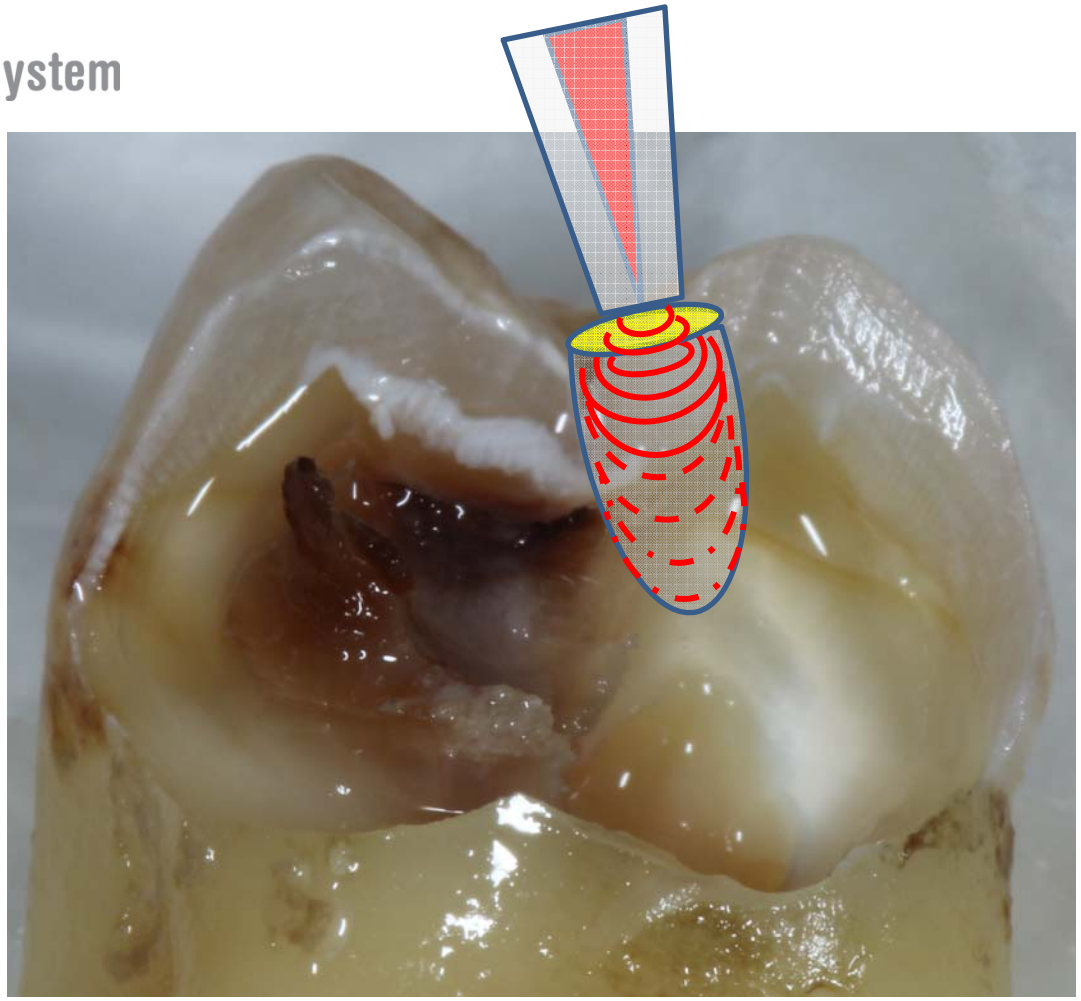
The Canary System



CANARY NUMBER
16

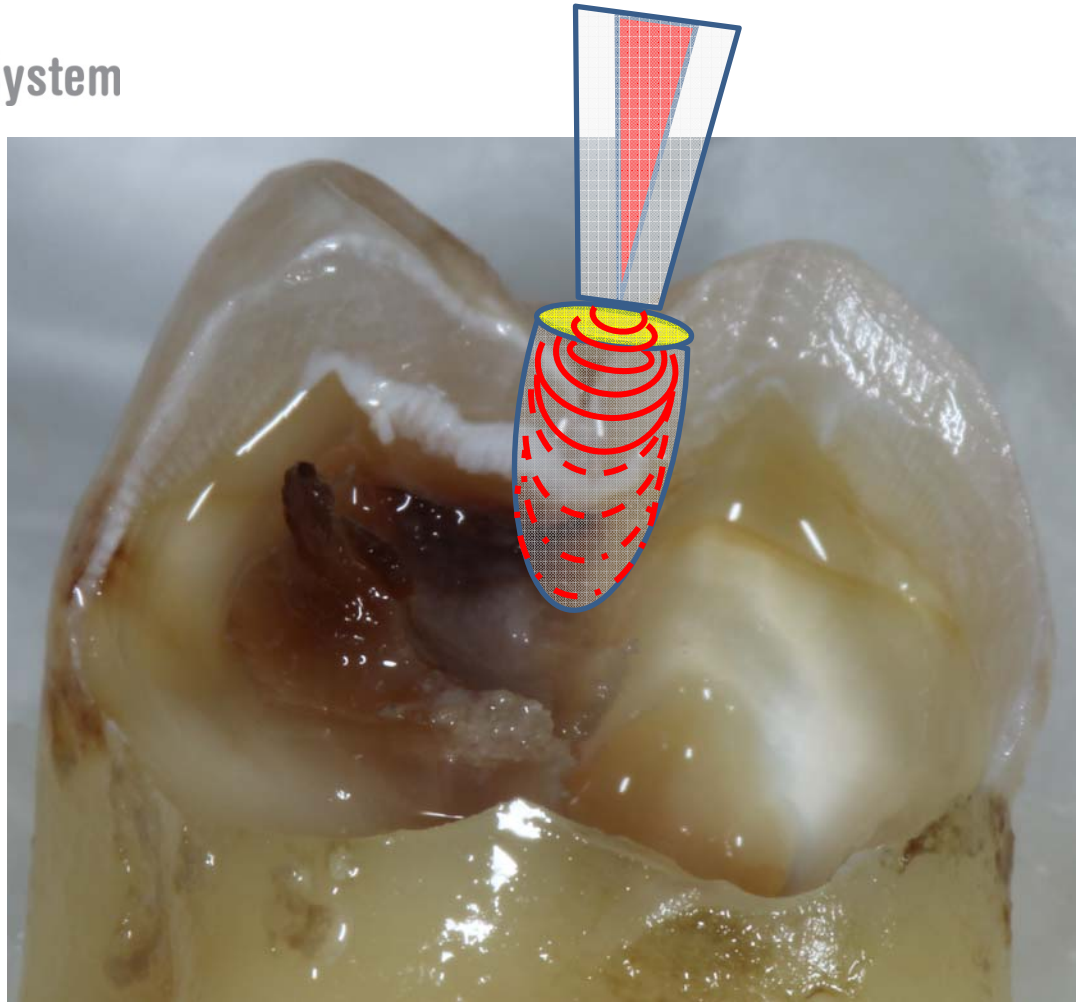
Scanning the Occlusal Surface to Map the Lesion

The Canary System



CANARY NUMBER
16
19

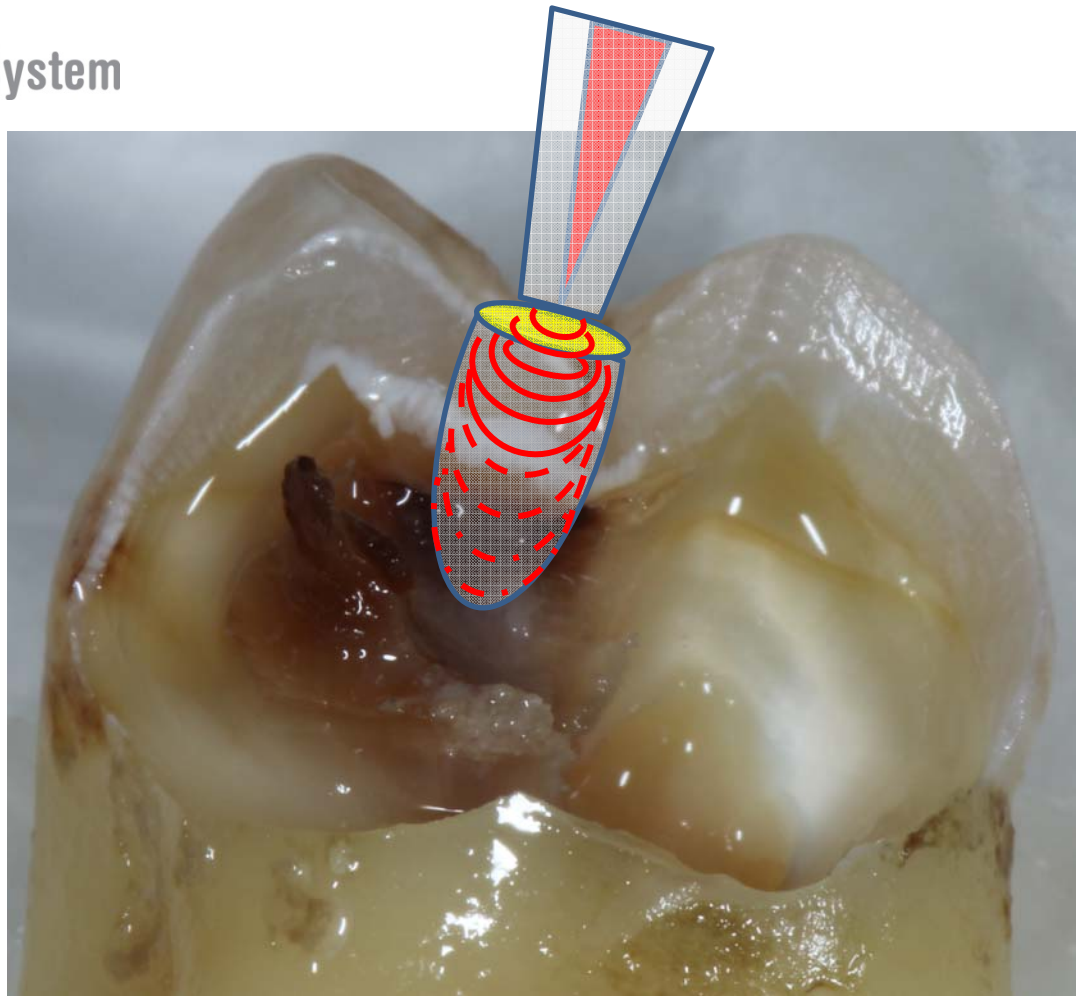
The Canary System



CANARY NUMBER
16
19
35

Scanning the Occlusal Surface to Map the Lesion

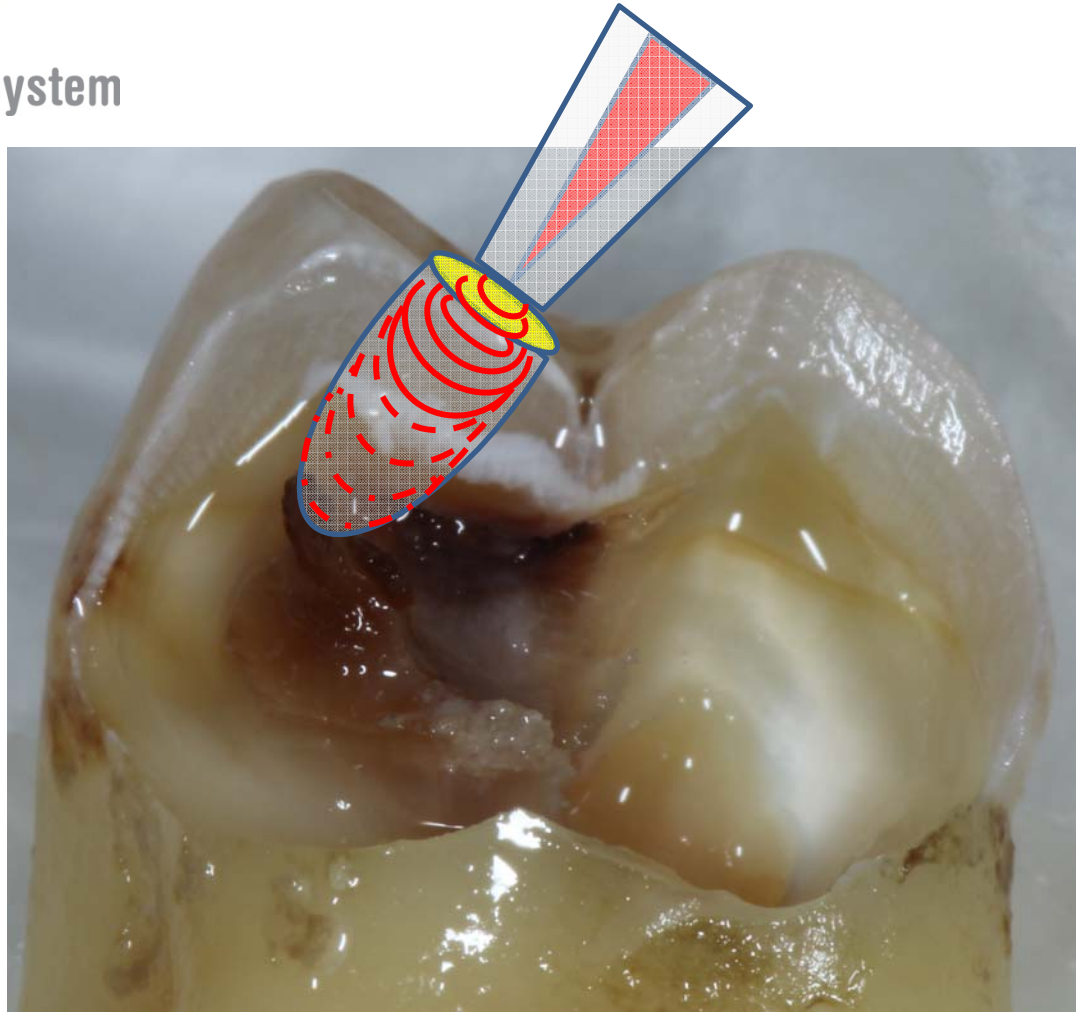
The Canary System



CANARY NUMBER
16
19
35
75

Scanning the Occlusal Surface to Map the Lesion

The Canary System



CANARY NUMBER
16
19
35
75
80

Scanning the Occlusal Surface to Map the Lesion

DIAGNOdent Scale

Source: DIAGNOdent Operating Guide

Spectra Scale

Displayed Color	Green → Blue → Red → Orange → Yellow
Displayed Number	1.0 → >3.0
Examine for	Healthy Tooth → Use Gold Standard techniques to examine for potential caries.

Source: Spectra Operators Manual

Materials and Methods - Validation

- Polarized Light Microscopy (PLM) was performed blinded at the Department of Comprehensive Dentistry, University of Texas Health Science Center at San Antonio as validation.

The Canary System

Statistical Analysis - Correlation

- Correlation between ICDAS II scores and the numerical readings from The Canary System, DIAGNOdent and Spectra and the scores from Radiographic Examination were determined by Pearson's coefficient of correlation (R2, $p < 0.01$).
- Correlation between lesion depth and the numerical readings from The Canary System, DIAGNOdent, Spectra and ICDAS II scores were determined by Pearson's coefficient of correlation (R2, $p < 0.01$).

The Canary System

Statistical Analysis – Sensitivity & Specificity

Sensitivity and specificity were determined using PLM results and the following criteria:

Device	Sound	Caries
Canary Number	≤ 20	> 20
DIAGNODent	≤ 10	> 10
SPECTRA	≤ 1	> 1
ICDAS II	= 0	≥1

The Canary System

RESULTS

Correlation with ICDAS II

Caries Detection Method	Correlation with ICDAS II Scores (R^2)
The Canary System	0.798
DIAGNOdent	0.244
Spectra	0.592
Radiographic Examination	0.091

The Canary System

Correlation with Lesion Depth (PLM)

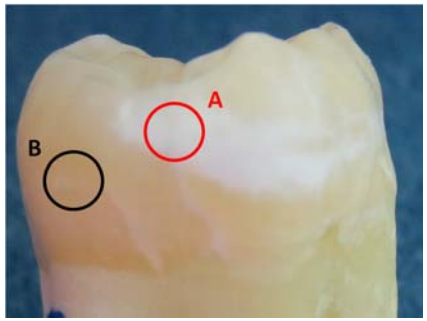
Caries Detection Method	Correlation with Lesion Depths (R^2)
The Canary System	0.583
DIAGNOdent	0.550
Spectra	0.423
ICDAS II	0.470

The Canary System

Representative Sample (#5A)

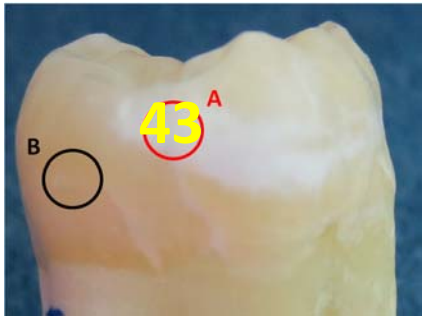
Representative sample with visually-carious examination site A and healthy examination site B.

Site A
ICDAS ≥1



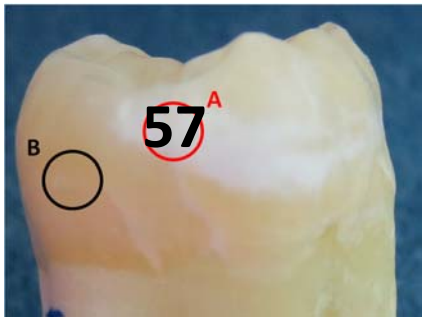
True Positive

Site A
Canary Number = 43



True Positive

Site A
DIAGNOdent = 57



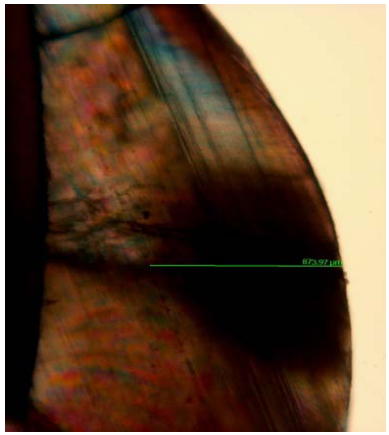
True Positive

Site A
Spectra Value = 0

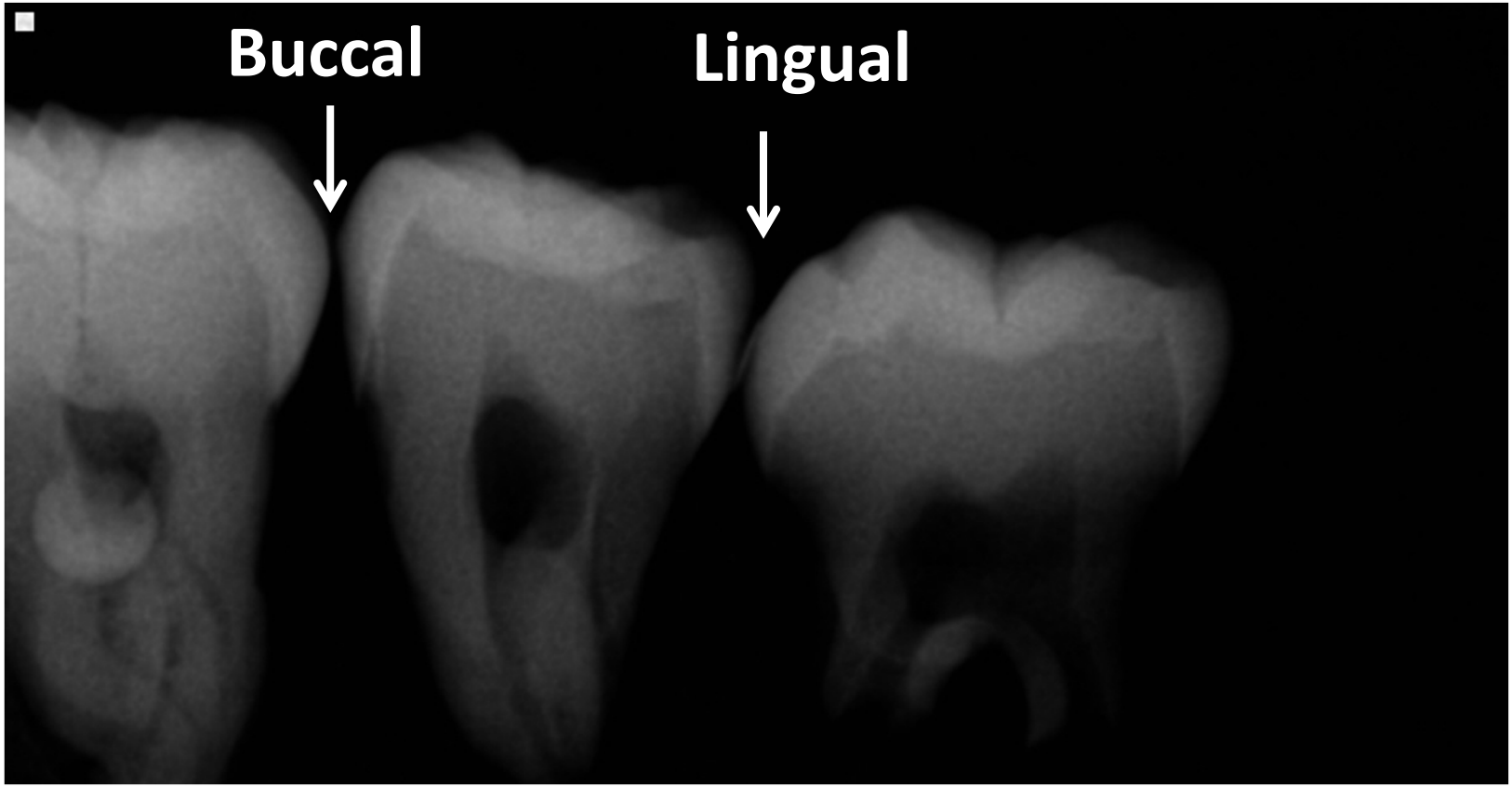
False Negative

Site A
PLM = 874 um

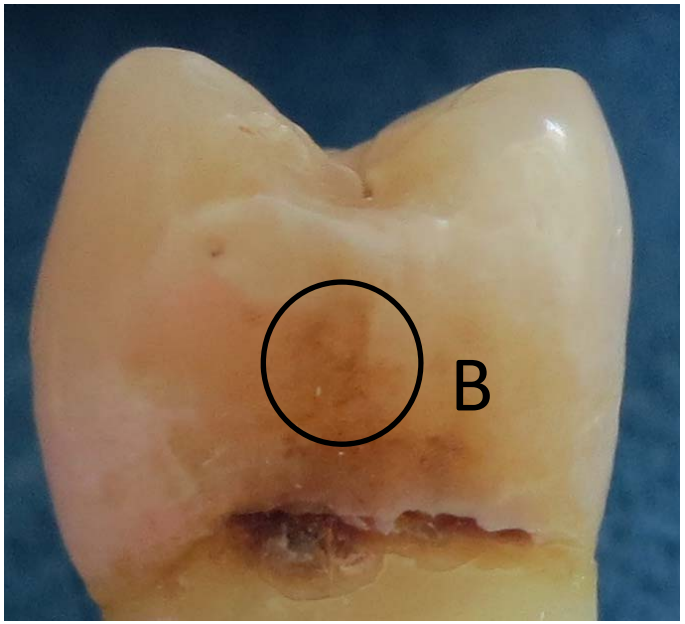
Gold Standard

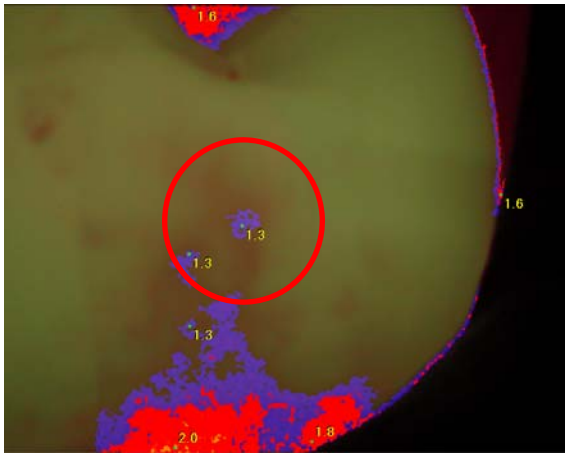


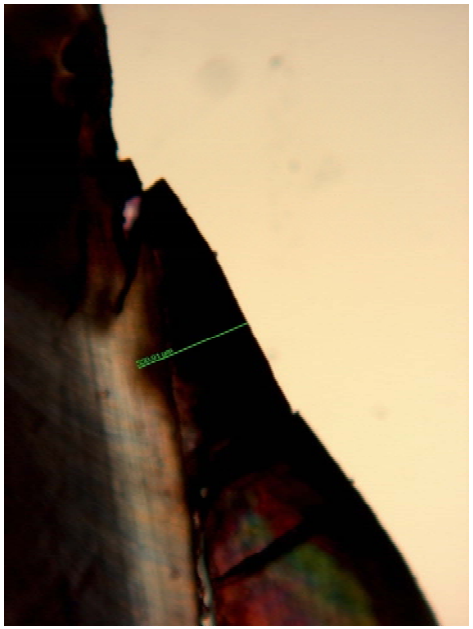
Radiographic Exam Sample 5A



Sample 10B

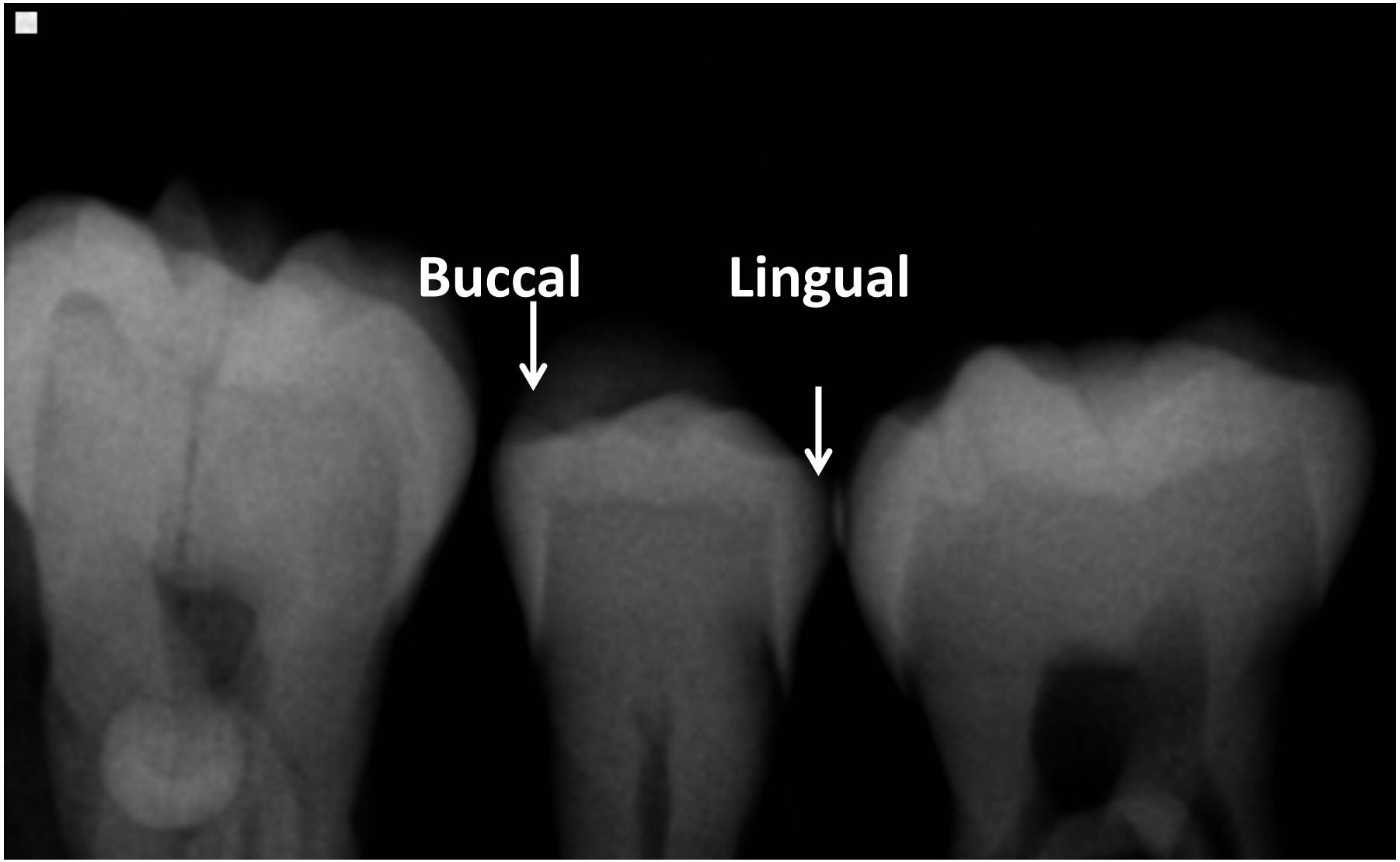






Device	Reading	
Canary	66	True Positive
DIAGNODent	1	False Negative
ICDAS II	2	True Positive
SPECTRA	0.9	False Negative
PLM Depth	550.91 microns	

Sample 10 Radiograph



Sensitivity & Specificity

Caries Detection Method	Sensitivity	Specificity
The Canary System	0.84	0.91
DIAGNOdent	0.49	1.00
Spectra	0.51	1.00
ICDAS II	0.83	1.00

The Canary System

Conclusions: Detecting Smooth Surface Caries

- Strong positive correlation between Canary Numbers & ICDAS II scores for detecting smooth surface caries.
- Spectra, DIAGNOdent & Radiographic Examination demonstrated poorer correlation with ICDAS II.
- ICDAS II may not be as sensitive to changes in lesion size within each classification.
- The strong correlation between The Canary System and ICDAS II implies that these two methods may be combined to increase their effectiveness for detection of caries on **smooth surfaces**.
- ICDAS II & The Canary System showed superior sensitivity compared to DIAGNOdent and Spectra.

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by Quantum Dental Technologies

Thank You

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